

Heavy Ion Single Event Effects Test Results for Agere LSP2916 16-Channel, High Voltage Driver (MEMS)

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I. INTRODUCTION

This study was undertaken to determine the radiation-induced single event effect (SEE) sensitivity of the Agere Systems (formerly Agilent) LSP2916 16-channel, high voltage driver for microelectromechanical systems (MEMS) applications, including optical MEMS. Heavy ion testing was done at Brookhaven National Laboratory's Single Event Upset Test Facility. The output of the device was monitored for radiation-induced errors.

II. DEVICES TESTED

The Agere Systems 16-channel, high voltage driver is designed for driving MEMS devices. The devices provide output from 0V to -298V with a output current limit of 50 μ A to 300 μ A per channel determined by an external resistor. The gain is fixed within the device to either -32V/V (AHA part) or -66V/V (BHA part). There were a total of four devices under test (DUT) (DUTs 9, 11, 6, 2). The DUTs were irradiated with several different ions. The devices were delidded before exposure. DUTs 9 and 11 were marked AGERE M-LSP2916AHA 0134M 51709, and DUTs 2 and 6 were marked AGERE M-LSP2916BHA 0140M 52044.

III. TEST FACILITIES

Heavy Ion Test Facility: Brookhaven National Laboratory Single Event Upset Test Facility.

Flux: $2.3 \times 10^4 - 6.1 \times 10^4$ particles/cm²/s.

Particles: linear energy transfer (LET)

Ion	LET (MeVcm ² /mg)
F-19	3.36
Si-28	7.88
Cl-35	11.44
Ni-58	26.6

IV. TEST METHODS

Case Temperature: ambient in a vacuum

Test Hardware: A custom test set was used to supply a nominal input levels to the DUTs and monitor the DUT output and power supply currents for changes resulting from the radiation exposure. Each radiation event occurring on the output was captured using a 1 GHz Tektronix TDS784C digitizing oscilloscope. A window comparator in the oscilloscope was used to determine if the DUT output deviated more than ± 0.5 V from the expected value along the sine wave. A counter built into the scope was used to count the number of triggers, i.e. single event transient (SET) or single event gate rupture (SEGR). An HP6626A power supply provided logic

voltage to the DUTs. Input supply voltage was provided by an HP6030A -200V power supply. An HP8116A function generator provided the input sine wave signal.

Software: Customized LABVIEW[®] software provided a user interface to control signals to the DUTs. The software also automatically monitored the DUT output (via a trigger from the hardware) and generated an SET/SEL file history.

Test Techniques: Tests were performed on the DUTs to measure the SET/SEGR susceptibility as a function of particle LET for the specific application described in this report. Any deviations from the application described should be reviewed carefully. The test setup did not allow for monitoring or changing the temperature, therefore temperature effects were not considered. The device could not be rotated more than 30° due to self-shielding from the DUT test socket. The logic power supply was set at +5V with nominal current; the device power supply was set to –200VDC. The input signal was a 1kHz sine wave, ranging from 0V to 2.5V for both device types. The test setup shown in Figure 1 allows the user to monitor any four of the 16 channels at a time. The LETs for the various ions used are presented in Table 1.

The device was deemed to have experienced an SET when the output deviated by more than $\pm 0.5V$ from the expected sine wave. The shortest duration trace that can be captured is approximately 1ns. The device was deemed to have experienced an SEL when the output ceased to function. The number of deviations during an irradiation was tabulated. An oscilloscope was used to capture all events.

V. RESULTS

The devices showed no evidence of SETs during the testing.

The device exhibited what appears to be a destructive SEGR at an LET of $<26.6 \text{ MeVcm}^2/\text{mg}$ (Ni-58 at normal incidence). It should be noted that there is a gap in LETs tested to do availability of beam, therefore the actual limiting LET may be slightly lower. The SEGR rendered the entire device non-functional due to the partial vaporization of the V_{LP} bond wire (A type, –33V/V gain devices) or the complete vaporization of the V_{LP} , V_{HN} and GND bond wires. See Figures 2 and 3 for views of DUT 2 (B type, -66V/V gain devices). When the SEGR occurred, in all cases, a spark was visible on the test vacuum chamber CCTV monitor. In the case of DUT 11, the first run with Ni probably caused a momentary melt that self-healed. The subsequent run caused a permanent failure. See Table 1 for a list of exposures and run information.

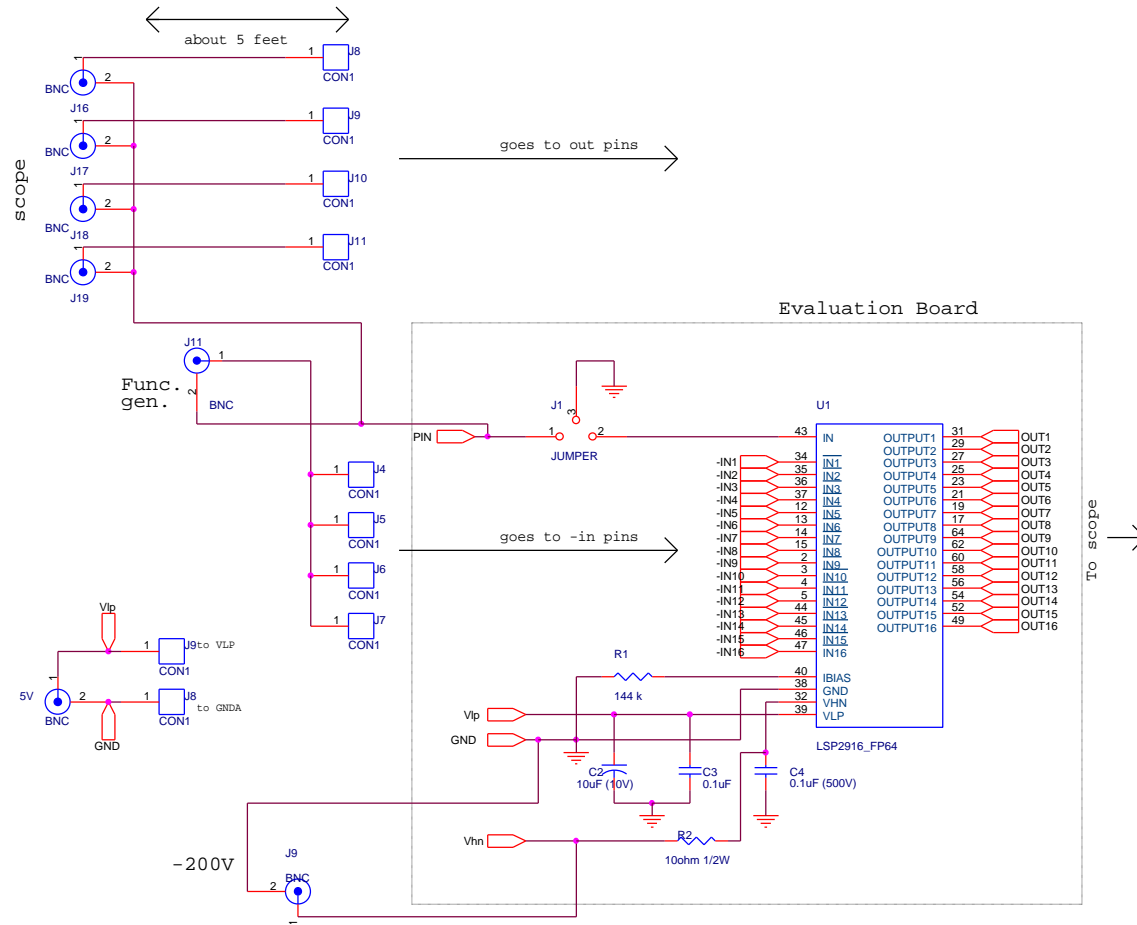


Figure 1: Circuit Diagram of the LSP2916 Test Setup

Table 1. List of All Exposures

DUT	Ion	Angle of Incidence	LET _{EFF} (MeV cm ² /mg)	Step Fluence (particles/cm ²)	Total Fluence (particles/cm ²)	SEL
9	Ni-58	0	26.6	9.80x10 ⁶	9.80x10 ⁶	Yes
11	F-19	0	3.36	1.00x10 ⁷	1.00x10 ⁷	No
11	F-19	30	3.88	1.00x10 ⁷	2.00x10 ⁷	No
11	Si-28	0	7.88	1.00x10 ⁷	3.00x10 ⁷	No
11	Si-28	30	9.10	1.00x10 ⁷	4.00x10 ⁷	No
11	Cl-35	0	11.44	1.00x10 ⁷	5.00x10 ⁷	No
11	Cl-35	30	13.21	1.00x10 ⁷	6.00x10 ⁷	No
11	Ni-58	0	26.6	3.18x10 ⁶	6.32x10 ⁷	Yes*
11	Ni-58	0	26.6	2.20x10 ⁶	6.54x10 ⁷	Yes
6	Ni-58	0	26.6	2.80x10 ⁶	2.80x10 ⁶	Yes
2	Cl-35	0	11.4	1.00x10 ⁷	1.00x10 ⁷	No
2	Cl-35	30	13.16	1.00x10 ⁷	2.00x10 ⁷	No
2	Ni-58	0	26.6	5.70x10 ⁵	5.70x10 ⁵	Yes

* This SEL did not completely destroy the part, the subsequent run did.

Please note that there is a difference in LET of 13.4 between Cl-35 at 30° and Ni-58 at 0°. The actual limiting SEL LET may be between these values.

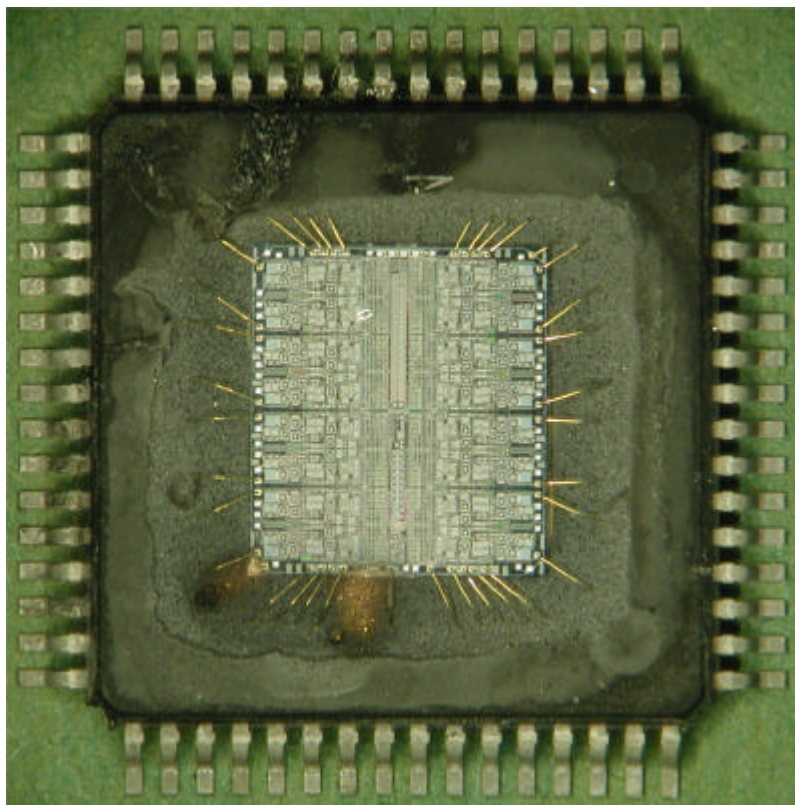


Figure 2: Full view of DUT 2 with vaporized bond wires.

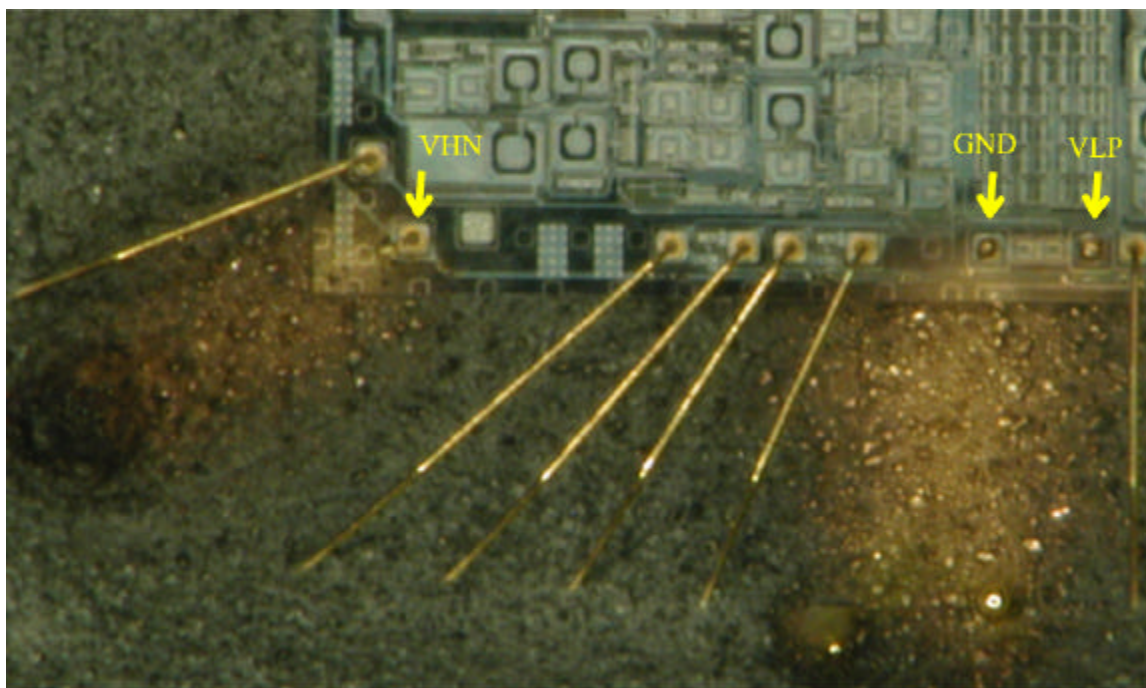


Figure 3: Detail view of DUT 2 with vaporized bond wires. Note that there were additional melt points along the traces of all three affected pins that are not visible in this photograph.